

THE CLAIMS

What is claimed is:

1. A bottom anti-reflection coating (BARC) removal composition, comprising at least one SCF, at least one co-solvent, at least one etchant and at least one surfactant.
2. The BARC removal composition of claim 1, wherein the SCF comprises a fluid selected from the group consisting of carbon dioxide, oxygen, argon, krypton, xenon, and ammonia.
3. The BARC removal composition of claim 1, wherein the SCF comprises carbon dioxide.
4. The BARC removal composition of claim 1, wherein the co-solvent comprises at least one C₁-C₆ alkanol.
5. The BARC removal composition of claim 1, wherein the co-solvent comprises isopropanol.
6. The BARC removal composition of claim 1, wherein the co-solvent comprises an amine selected from the group consisting of monoethanolamine, triethanolamine, triethylenediamine, methyldiethanolamine, pentamethyldiethylenetriamine, diglycolamine, N-methylpyrrolidone (NMP), N-octylpyrrolidone, N-phenylpyrrolidone and vinyl pyrrolidone.

7. The BARC removal composition of claim 1, wherein the etchant comprises at least one of HF, ammonium fluoride, triethylamine trihydrofluoride, hydrogen peroxide, acetic acid, nitric acid and sulfuric acid.
8. The BARC removal composition of claim 1, wherein the etchant comprises triethylamine trihydrofluoride.
9. The BARC removal composition of claim 1, wherein the surfactant comprises at least one nonionic surfactant or at least one anionic surfactant.
10. The BARC removal composition of claim 9, wherein the nonionic surfactant comprises at least one species selected from the group consisting of fluoroalkyl surfactants, ethoxylated fluorosurfactants, polyethylene glycols, polypropylene glycols, polyethylene ethers, polypropylene glycol ethers, carboxylic acid salts, dodecylbenzenesulfonic acid, dodecylbenzenesulfonic salts, polyacrylate polymers, dinonylphenyl polyoxyethylene, silicone polymers, modified silicone polymers, acetylenic diols, modified acetylenic diols, alkylammonium salts, modified alkylammonium salts.
11. The BARC removal composition of claim 9, wherein the surfactant comprises an ethoxylated fluorosurfactant.
12. The BARC removal composition of claim 9, wherein the anionic surfactant comprises at least one species selected from the group consisting of fluorosurfactants, sodium alkyl sulfates, ammonium alkyl sulfates, C₁₀-C₁₈ alkyl carboxylic acid ammonium salts, sodium sulfosuccinates and esters thereof, and C₁₀-C₁₈ alkyl sulfonic acid sodium salts.

13. The BARC removal composition of claim 1, wherein the SCF-based removal composition comprises about 60.0 wt % to about 90.0 wt % SCF, about 10.0 wt % to about 30.0 wt % co-solvent, about 0.01 wt % to about 5.0 wt % etchant, and about 0.01 wt % to about 5.0 wt % surfactant, based on the total weight of the composition.
14. A bottom anti-reflection coating (BARC) removal composition, comprising supercritical carbon dioxide (SCCO₂), triethylamine trihydrofluoride, a fluorosurfactant and isopropyl alcohol.
15. A method of removing a bottom anti-reflection coating (BARC) layer from a substrate having same thereon, said method comprising contacting the substrate having the BARC layer thereon with an SCF-based removal composition comprising at least one SCF, at least one co-solvent, at least one etchant, and at least one surfactant, for sufficient time and under sufficient contacting conditions to at least partially remove the BARC layer from the substrate.
16. The method of claim 15, wherein the SCF comprises a fluid selected from the group consisting of carbon dioxide, oxygen, argon, krypton, xenon, and ammonia.
17. The method of claim 15, wherein the SCF comprises carbon dioxide.
18. The method of claim 15, wherein the contacting conditions comprise pressure in a range of from about 1500 psi to about 4500 psi.

19. The method of claim 15, wherein said contacting time is in a range of from about 1 minutes to about 20 minutes.
20. The method of claim 15, wherein the co-solvent comprises at least one C₁-C₆ alkanol.
21. The method of claim 15, wherein the co-solvent comprises isopropanol (IPA).
22. The method of claim 15, wherein the co-solvent comprises an amine selected from the group consisting of monoethanolamine, triethanolamine, triethylenediamine, methyldiethanolamine, pentamethyldiethylenetriamine, diglycolamine, N-methylpyrrolidone (NMP), N-octylpyrrolidone, N-phenylpyrrolidone and vinyl pyrrolidone.
23. The method of claim 15, wherein the etchant comprises at least one of HF, ammonium fluoride, triethylamine trihydrofluoride, hydrogen peroxide, acetic acid, nitric acid and sulfuric acid.
24. The method of claim 15, wherein the etchant comprises triethylamine trihydrofluoride.
25. The method of claim 15, wherein the surfactant comprises at least one nonionic surfactant or at least one anionic surfactant.
26. The method of claim 25, wherein the surfactant comprises at least one species selected from the group consisting of fluoroalkyl surfactants, ethoxylated fluorosurfactants, polyethylene glycols, polypropylene glycols, polyethylene ethers, polypropylene glycol ethers, carboxylic acid salts,

dodecylbenzenesulfonic acid, dodecylbenzenesulfonic salts, polyacrylate polymers, dinonylphenyl polyoxyethylene, silicone polymers, modified silicone polymers, acetylenic diols, modified acetylenic diols, alkylammonium salts, modified alkylammonium salts, and combinations comprising at least one of the foregoing.

27. The method of claim 25, wherein the anionic surfactant comprises at least one species selected from the group consisting of fluorosurfactants, sodium alkyl sulfates, ammonium alkyl sulfates, C₁₀-C₁₈ alkyl carboxylic acid ammonium salts, sodium sulfosuccinates and esters thereof, and C₁₀-C₁₈ alkyl sulfonic acid sodium salts.
28. The method of claim 15, wherein the SCF-based removal composition comprises about 60.0 wt % to about 90.0 wt % SCF, about 10.0 wt % to about 30.0 wt % co-solvent, about 0.01 wt % to about 5.0 wt % etchant, and about 0.01 wt % to about 5.0 wt % surfactant, based on the total weight of the composition.
29. The method of claim 15, wherein the BARC layer comprises an organic BARC layer.
30. The method of claim 15, wherein the BARC layer comprises an inorganic BARC layer.
31. The method of claim 15, wherein the contacting step comprises a cycle including (i) dynamic flow contacting of the SCF-based removal composition with the substrate having the BARC layer thereon, and (ii) static soaking

contacting of the SCF-based removal composition with the substrate having the BARC layer thereon.

32. The method of claim 31, wherein said cycle comprises alternately and repetitively carrying out dynamic flow contacting (i) and static soaking contacting (ii) of the substrate having the BARC layer thereon.
33. The method of claim 15, further comprising washing the substrate, at a region at which the BARC layer has been removed, with a SCF/methanol/deionized water wash solution in a first washing step, and with a SCF in a second washing step, to remove residual precipitated chemical additives in said first washing step, and to remove residual precipitated chemical additives and/or residual alcohol in said second washing step.
34. The method of claim 33, wherein the SCF comprises SCCO_2 .
35. The method of claim 15, wherein the contacting conditions comprise temperature in a range of from about 50°C to about 90°C.
36. A method of removing an ion implanted photoresist layer and a bottom anti-reflection coating (BARC) layer from a substrate having same thereon, said method comprising contacting the substrate having the photoresist layer and the BARC layer thereon with a SCF-based removal composition comprising at least one SCF, at least one co-solvent, at least one etchant, and at least one surfactant, for sufficient time and under sufficient contacting conditions to at least partially remove the photoresist layer and the BARC layer from the substrate.